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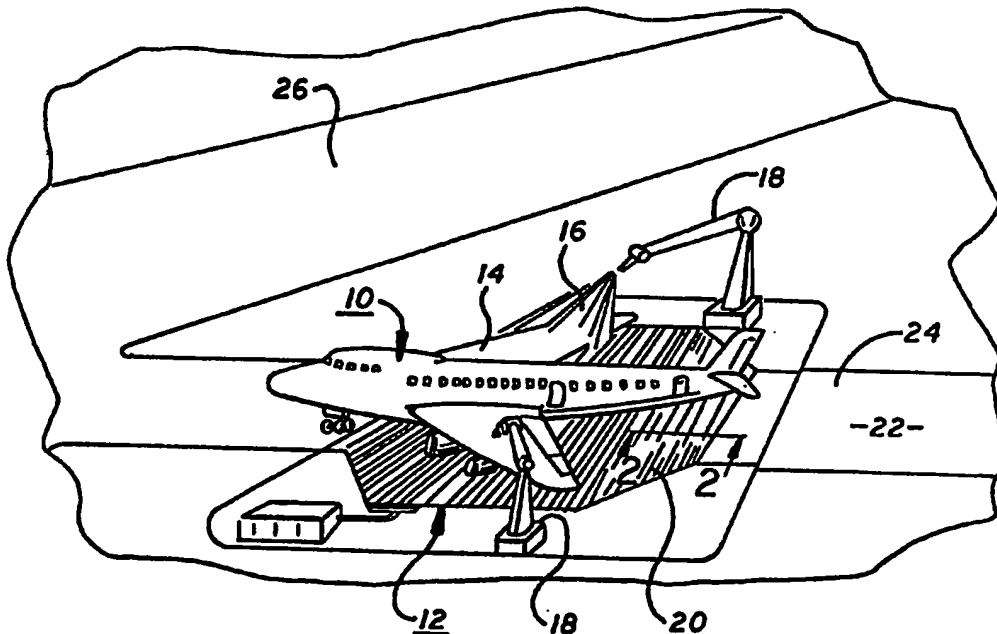
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(54) Title: AIRCRAFT DE-ICING AND RECOVERY SYSTEM



## (57) Abstract

A system (12) for collecting and recovering de-icing fluid (16) that is sprayed on an aircraft (10). The de-icing system (12) includes a mat (20) that is assembled onto the approaching ramp of a runway (26). The de-icing mat (20) has a plurality of channels (28) that collect and direct the de-icing fluid (16) to the outer edges of the mat (20). The de-icing fluid (16) is removed from the mat (20) by a vacuum system (34). Coupled to the vacuum system (34) is a filter system (38) that separates the de-icing fluid (16) from other fluids such as oil, water, etc., so that the de-icing fluid (16) can be used again. The mat (20) has a plurality of heating elements (30) that prevent the de-icing fluid (16) from freezing on the mat (20) and provide heat to the underside of the aircraft (10).

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# **AIRCRAFT DE-ICING AND RECOVERY SYSTEM**

## **BACKGROUND OF THE INVENTION**

### **1. FIELD OF THE INVENTION**

The present invention relates to a system for collecting and recovering de-icing fluid that is sprayed onto an aircraft.

### **2. DESCRIPTION OF RELATED ART**

When flying an aircraft it is important that all of the control surfaces such as the aileron and the flaps move freely. The formation of ice on the wings of an airplane can affect the movement of the control surfaces and the operation of the vehicle. Additionally, the ice may break away from the wing and be ingested by an engine, possibly causing a failure of the engine and endangering the safety of the passengers of the aircraft. To remove and prevent the build-up of ice on the wings, the skin of the wings can be sprayed with a fluid that has a low freezing point, such as a glycol. In cold climates the wings are typically sprayed at the airport before takeoff.

The glycol that is sprayed onto the wings falls off of the plane and flows into a drainage system which removes the de-icing fluid. A vehicle is typically sprayed with gallons of de-icing fluid that is used only one time. It would be desirable to provide a recovery system that can collect and recycle de-icing

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fluid sprayed onto an airplane so that the fluid can be reused. Recycling the de-icing fluid would decrease the cost of spraying the aircraft.

Glycol is generally considered a hazardous material that requires specialized handling and storage. For this reason, aircraft are typically sprayed with de-icing fluid at a remote location. Having to maneuver each airplane to the de-icing area requires valuable time which can disrupt airport scheduling. It would therefore be desirable to provide a portable de-icing fluid recovery system that can store hazardous material and be assembled at a location adjacent to the runway of an airport so that each aircraft can be readily sprayed with de-icing fluid.

**SUMMARY OF THE INVENTION**

The present invention is a system for collecting and recovering de-icing fluid that is sprayed onto an aircraft. The de-icing system includes a mat that is typically assembled at the runway switch of an airport. The de-icing mat has a plurality of channels that collect and direct the de-icing fluid to the outer edges of the mat. The de-icing fluid is removed from the mat by a vacuum system. Coupled to the vacuum system is a filter system that separates the de-icing fluid from other fluids such as oil, water, etc., so that the de-icing fluid can be used again. The mat has a plurality of heating elements that prevent the de-icing fluid from freezing on the mat and provide heat to the underside of the aircraft.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The objects and advantages of the present invention will become more readily apparent to those ordinarily skilled in the art after reviewing the following detailed description and accompanying drawings, wherein:

Figure 1 is a perspective view showing an aircraft within a recovery system of the present invention;

Figure 2 is a cross-sectional view of a mat of the recovery system;

Figure 3 is a schematic view of a vacuum pump and separating filter of the recovery system.

### **DETAILED DESCRIPTION OF THE INVENTION**

Referring to the drawings more particularly by reference numbers, Figure 1 shows an aircraft 10 located within a recovery system 12 of the present invention. To prevent the formation of ice on the wings 14 of the aircraft 10, the wings 14 are sprayed with a de-icing fluid 16 by a boom 18. There is typically one boom 18 for each wing 14. The booms 18 have pumps (not shown) and nozzles that can create a spray of de-icing fluid 16. The booms 18 may also have multiple degrees of freedom to allow the booms 18 to more accurately spray the wings of the aircraft 10. The de-icing fluid 16 is typically a glycol or other substance which has a freezing temperature significantly lower than the freezing temperature of water.

The recovery system 12 includes a mat 20 that extends across the top surface of an airport surface 22. In the preferred embodiment, the mat 20 is assembled from a plurality of individual pieces that are linked together. The individual pieces may have features that allow the pieces to be interlocked. The individual pieces allow the mat 20 be readily assembled and disassembled from any location of an airport. In the preferred embodiment, the mat 20 is assembled at the runway switch of 24 of a runway 26. Placing the recovery system 12 at the runway switch 24 allows the de-icing fluid 16 to be sprayed onto the aircraft as the vehicle taxis onto the runway 26. Spraying the aircraft 10 at the runway switch 24 reduces the amount of time required to de-ice the wings 14 of the plane. The mat 20

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is preferably constructed from a high strength polyurethane composite or other similar material that can withstand the weight of the airplane.

As shown in Figure 2, the mat 20 has a plurality of channels 28 that collect the de-icing fluid 16 that falls off of the airplane. The mat 20 may have a plurality of wires 30 that extend through ridge portions 32 that separate the channels 28. The wires 30 are connected to a power supply (not shown) that provides a current which generates heat within the mat 20. The heat created by the wires 30 prevent freezing of the de-icing fluid 16 and insure that the fluid 16 flows across the mat 20. The energized wires 30 can also provide heat to the underside of the aircraft to further melt any ice formed on the vehicle. The individual mat pieces can be constructed so that the wires 30 have a butt joint connection. Alternatively, the wires 30 may have connectors to join wires of adjacent mat pieces.

As shown in Figure 3, the recovery system 12 has a vacuum pump 34 that removes the de-icing fluid 16 from the mat 20. The vacuum pump 234 is coupled to the mat 20 by a plurality of tubes 36 that are located within the channels 28. The mat 20 may have a slope that causes the fluid 16 to flow to the outer edges of the mat 20 for removal by the vacuum pump 34. The slope can be created by varying the thickness of the mat 20, or placing an additional layer under the mat 20.

Coupled to the vacuum pump 34 is a filter system 38 which filters and separates the de-icing fluid 16 from other



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fluids and materials that are collected and recovered from the mat 20. By way of example, the filter system 38 may contain a separator that separates the de-icing fluid 16 from oil that may be collected by the system. The filtered de-icing fluid 16 is stored within a reservoir 40 for subsequent reuse.

In operation, the mat 20 is assembled onto the runway switch 24 by connecting the various individual pieces of the mat 20. The wires 30 are then connected to the power supply and the vacuum pump 34 and filter system 38 are assembled and coupled to the mat 20 by the tubes 36 which are placed within the channels 28. Before takeoff, the aircraft 10 will be driven onto the mat 20, where the wings 14 are sprayed with de-icing fluid 16. The fluid 16 is collected by the mat 20, removed from the mat 20 by the vacuum pump 34 and filtered by the filter system 38 for storage in the reservoir 40. When de-icing is no longer required, the recovery system 12 can be removed by disassembling the various components and storing the same. The present invention thus provides a system that recovers de-icing fluid 16 and reduces the cost for operating a de-icing system. Additionally, the present invention provides a system for handling and storing hazardous de-icing fluids and allows the aircraft to be de-iced at the runway switch of an airport.

While certain exemplary embodiments have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad invention, and that this invention not be limited to the specific constructions and arrangements

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shown and described, since various other modifications may occur to those ordinarily skilled in the art.

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What is claimed is:

1. A system for recovering de-icing fluid that is sprayed onto an aircraft, comprising:  
a mat that collects the de-icing fluid; and,  
a vacuum device that removes the de-icing fluid from said mat.
2. The system as recited in claim 1, further comprising a filter system that filters and separates the de-icing fluid from another fluid collected by said mat and removed by said vacuum device.
3. The system as recited in claim 1, wherein said mat contains a plurality of channels.
4. The system as recited in claim 1, wherein said mat contains a heating element.
5. The system as recited in claim 4, wherein said heating element includes a plurality of wires.
6. The system as recited in claim 1, wherein said mat includes a plurality of individually pieces that are attached together.

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7. The system as recited in claim 3, wherein said vacuum device includes a plurality of tubes coupled to said channels.

8. The system as recited in claim 1, wherein said mat is sloped so that the de-icing fluid flows to an edge of said mat.

9. A system for recovering de-icing fluid that is sprayed onto an aircraft, comprising:  
a mat that collects the de-icing fluid;  
a heating element coupled to said mat;  
a vacuum device that removes the de-icing fluid from said mat; and,  
a filter system coupled to said vacuum device.

10. The system as recited in claim 9, wherein said mat contains a plurality of channels.

11. The system as recited in claim 9, wherein said heating element includes a plurality of wires.

12. The system as recited in claim 9, wherein said mat includes a plurality of individually pieces that are attached together.

13. The system as recited in claim 9, wherein said mat is sloped so that the de-icing fluid flows to an edge of said mat.

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14. The system as recited in claim 10, wherein said vacuum device includes a plurality of tubes coupled to said channels.

15. The system as recited in claim 14, wherein said heating element includes a plurality of wires.

16. The system as recited in claim 15, wherein said mat includes a plurality of individually pieces that are attached together.

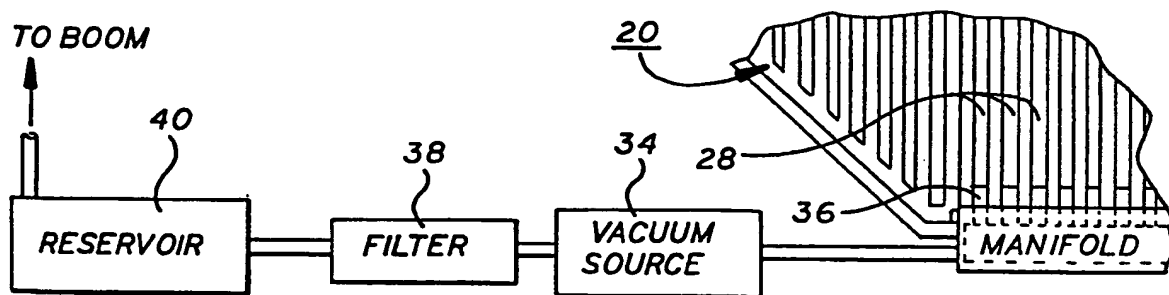
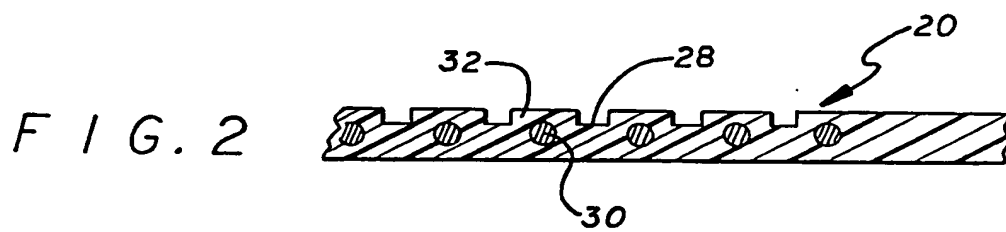
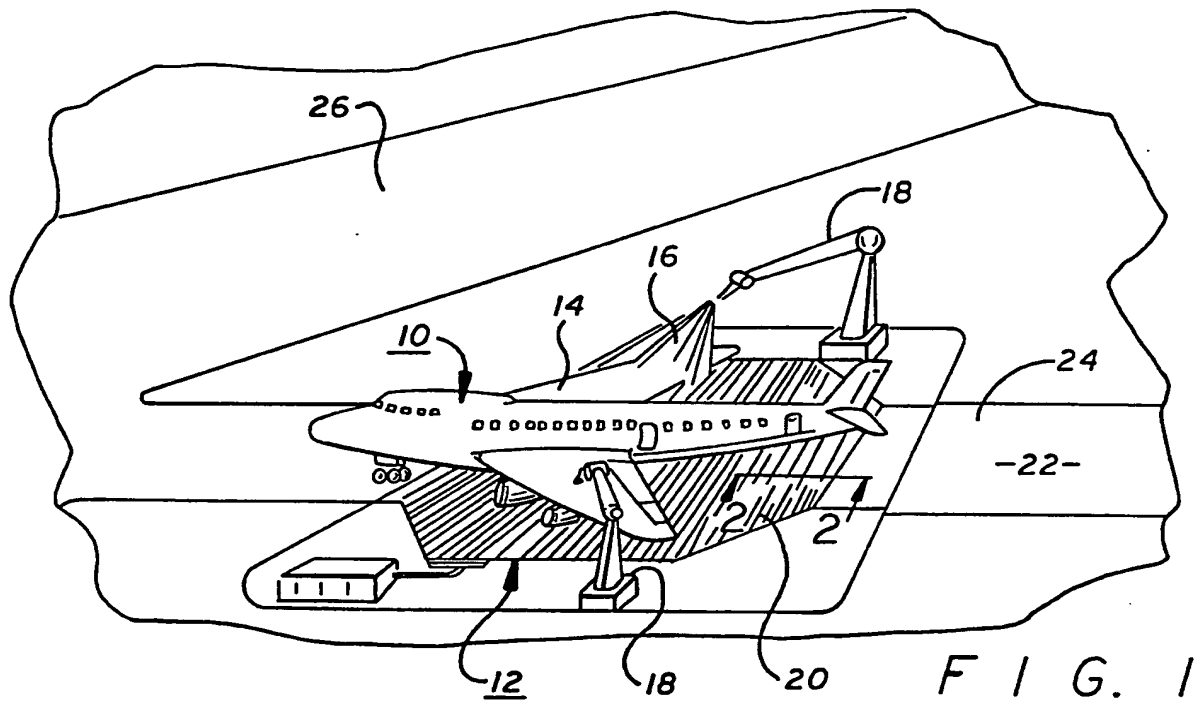
17. The system as recited in claim 16, wherein said mat is sloped so that the de-icing fluid flows to an edge of said mat.

18. A method for recovering a de-icing fluid that is sprayed onto an aircraft, comprising the steps of:

- a) collecting the de-icing fluid on a mat;
- b) removing the de-icing fluid from said mat.

19. The method as recited in claim 18, further comprising the step of separating the de-icing fluid from another fluid that is collected and removed from said mat.

20. The method as recited in claim 18, further comprising the step of heating said mat.



*F I G. 3*

## INTERNATIONAL SEARCH REPORT

International application No.  
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<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(6) :B64D 15/10 US CL :244/134R; 15/215; 404/35 According to International Patent Classification (IPC) or to both national classification and IPC														
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) U.S. : 244/134R, 134C; 15/215, 310; 404/35; 210/652; 219/549 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)														
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>														
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X --- Y	US, A, 5,003,157 (Hargrove) 26 March 1991, see figures 7 and 8.	1, 3-5, 8 ----- 3-7, 9-16, 20												
X --- Y	US, A, 5,060,887 (Kean) 29 October 1991, see entire document.	1-2, 8, 18-19 ----- 3-7, 9-16, 20												
Y	US, A, 3,348,459 (Harvey) 24 October 1967, see figure 11	6, 16												
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**INTERNATIONAL SEARCH REPORT**International application No.  
PCT/US95/06033**C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 3,165,773 (Palpacelli) 19 January 1965, see figures 1-3.	



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